

Two years of BSRN measurements at De Aar, South Africa

Katlego Ncongwane, Lucky Ntsangwane, Brighton Mabasa & Jyotsna Singh

South African Weather Service, Pretoria, South Africa

Latitude (N/S): 30.6647°S (30°39'53"), Longitude (E/W): 23.9925°E (23°59'33")

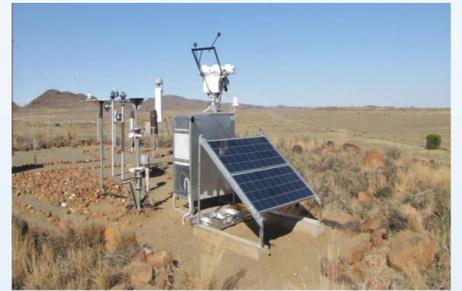


Figure 1: Geographical position of De Aar BSRN station, South Africa

Introduction

Since the 28th of July 1999, the South African De Aar Baseline Surface Radiation Network (BSRN) station is operational as number 40 in the global network and is 1 of 4 in the African Continent. The station operated nearly for a decade, approximately 9 years and ceased operation in 2008 due to operational difficulties. On the 20th of April 2014 the station was reinstated.

Site Description

- Centrally locate in the Country
- Pristine atmosphere
- Semi-arid with relatively low rainfall
- Aerial appearance of land is uniform
- small town with low population and metropolitan growth
- Max and Min Temperature vary from 0 in winter to 33° C in summer
- Likelihood of snow 1 out of 450 or 0.8 days per year

Irradiance Measurements

- Global Horizontal Irradiance (GHI) (Wm^{-2}) | Kipp & Zonen CMP21 (unshaded)
- Diffuse Horizontal Irradiance (DHI) (Wm^{-2}) | Kipp & Zonen CMP21 (shaded)
- Direct Normal Irradiance (GHI) (Wm^{-2}) | Kipp & Zonen CHP1
- Downward Long-wave radiation (OLR)(Wm^{-2}) | Kipp & Zonen CGR4
- UVA & UVB (Wm^{-2}) | Kipp & Zonen UV-S-AB-T
- Meteorological parameters (temperature, humidity, wind speed and direction, pressure and rain).

Irradiance Measurements at De Aar BSRN Station

Monthly average solar radiation data plots (GHI,DHI, DNI and OLR) for De Aar BSRN station are shown Figure 2 - 4. The calculated averages are based on data collected from April 2014 to March 2016.

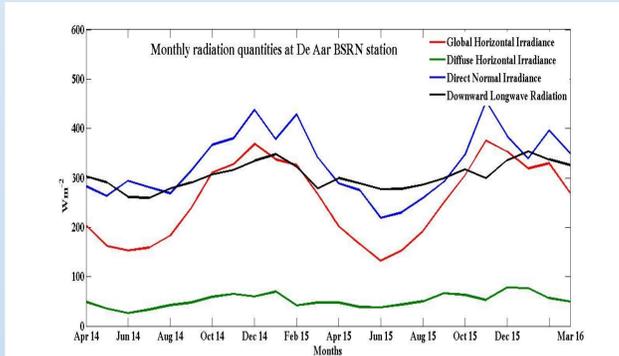


Figure 2: Approximately two years of monthly radiation quantities at De Aar BSRN station

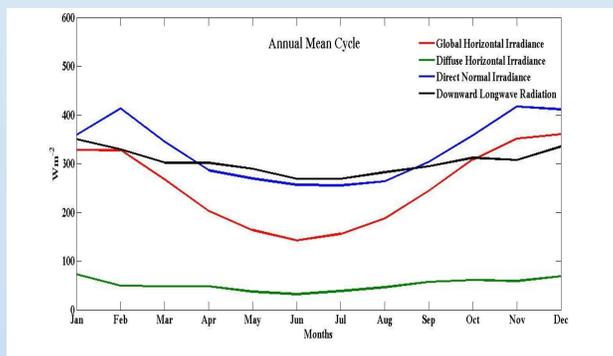


Figure 3: Annual Mean Cycle

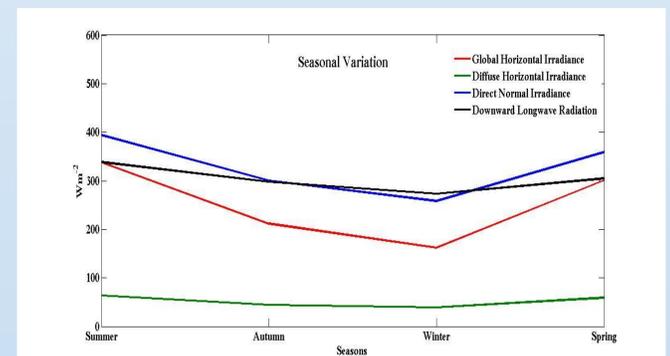


Figure 4: Seasonal variation

Comparison to CM SAF SARAH

Satellite-based irradiance (GHI and DNI) measurements from the Surface Solar Radiation Data Set - Heliosat (SARAH) were compared to ground-based (GHI and DNI) measurements at De Aar BSRN station. At the time of performing the comparison there was only data available for 2014. Since De Aar BSRN station data is available from April 2014, the comparison was done from April to December 2014 for which the data are available.

Data

SARAH data are available from 1983 to 2014 and cover the region $\pm 65^\circ$ longitude and $\pm 65^\circ$ latitude. Figure 5 & 6 display GHI and DNI comparison plots from May to December 2014.

Results

Global Horizontal Irradiance					
Months	MBD (Wm^{-2})	rMBD (%)	Av meas (Wm^{-2})	Av sat (Wm^{-2})	n
[04-12]	2.21	0.95	233.57	235.57	5558
Direct Normal Irradiance					
Months	MBD (Wm^{-2})	rMBD (%)	Av meas (Wm^{-2})	Av sat (Wm^{-2})	n
[04-12]	5.13	1.59	323.23	328.36	5556

Table 1: Comparison of satellite estimate and ground-based GHI and DNI for De Aar BSRN station available in 2014

Analysis

Table 1 show the results of the comparison of ground-based and CM SAF SARAH data set from May to December 2014. Statistical analysis (Mean Bias Difference (MBD), Relative Mean Bias Difference (rMBD), the average ground-based and satellite estimated irradiance and number of points) are given.

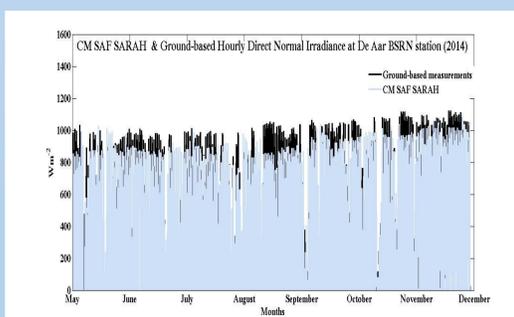


Figure 5: Hourly Direct Normal Irradiance and CM SAF SARAH at De Aar BSRN station

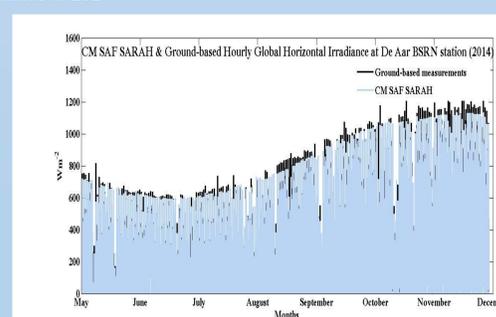
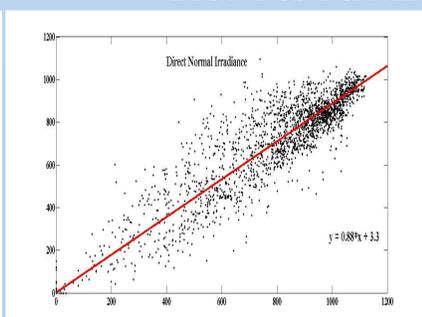
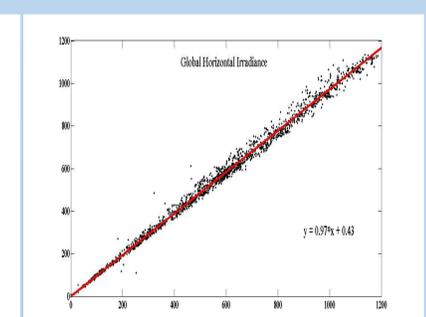


Figure 6: Hourly Global Horizontal Irradiance and CM SAF SARAH at De Aar BSRN station



There is an overall good agreement between the De Aar CM SAF and ground-based measurements. The systematic underestimation by CM SAF SARAH is relatively small, more specifically for the GHI parameter. The good correlation can be attributed to the atmospherically clean location of the De Aar BSRN station that is characterized by many clear sky days in a year. The local sources of pollution are relatively small and as such the amount of absorbing aerosols or trace gases is very low. The comparison of satellite and ground-based data provides confidence in the use of satellite based data largely used together with ground-based data to develop high resolution solar atlas that will provide precise knowledge of the geographical spread and temporal variability of solar resource in South Africa and the world.

Remarks

- Historic data for De Aar BSRN station is available from 1999 to 2008.
- New data for De Aar BSRN station starts from April 2014.
- Better agreement of CM SAF and ground-based measurements is anticipated for sites such as De Aar that often experience cloudless conditions and less pollution for most part of the year.

Acknowledgements

A special thanks to the staff at De Aar weather office for their efforts in maintain the De Aar BSRN station.

References

Müller, Richard; Pfeifroth, Uwe; Träger-Chatterjee, Christine; Cremer, Roswitha; Trentmann, Jörg; Hollmann, Rainer. (2015): Surface Solar Radiation Data Set - Heliosat (SARAH) - Edition 1. Satellite Application Facility on Climate Monitoring. DOI:10.5676/EUM_SAF_CM/SARAH/V001. http://dx.doi.org/10.5676/EUM_SAF_CM/SARAH/V001